



*Workshop on Reliability Issues in Nanomaterials*  
*17-19 August, 2004, Boulder, Colorado*

# ***Metrologies for in-situ property measurement and reliability assessment in MEMS***

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**Maarten de Boer**  
**Sandia National Labs**



## *How does metrology affect your present work in nanomaterials?*

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- Strongly prefer non-contacting methods (i.e., optical) and non-contacting actuation (i.e., electrostatics) and in-situ test methods
- Interferometry for  $\pm 2.5$  nm deflection data (z)
  - Extract mechanical & surface properties
- Optical Moiré for  $\pm 1$  nm deflection data (x,y)
  - Extract surface properties
- AFM for topographic and frictional information
  - Develop contact mechanics models & constitutive laws
- SEM/FIB/TEM/XPS/FTIR/Auger/IFM ...



## *What questions relating to reliability of nanomaterials would you hope to see addressed in this workshop and report/roadmap?*

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- Structure of monolayer coatings, susceptibility of coatings to environmental degradation? Property/structure relationships for monolayers (adhesion, friction, wear, pstd)
- Effect of surface roughness on adhesion, friction & wear?
- Reliability of RF-MEMS – what is the role of contaminants ( $\Omega$ mic switches)? What is the role of trapped charge (cap. switches)
- Mechanical integrity of polysilicon (ideal  $\mu$ scale mechanical material – no fatigue, creep, low res. stress) vs metals (lower resistance, higher reflectivity, etc.)
- Relationship between processing & residual stress, stress gradient and material strength
- Can the material be the coating? (diamond MEMS)
- Anodic oxidation under high RH & electric field
- Relationship between in-situ test methods and real device failures
- Local temperature measurements (rel. of thermal actuators)
- ...



## ***What metrology issues are of the most significance to you for your work in the coming 5 to 10 years?***

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- Local information on coatings (uniformity of structure, defects & roles they play in monolayer degradation)
- Is coating the same in non line-of-sight areas?
- Dormancy – evolution of coatings
- Wear – sliding vs. impact wear
- Role of surface charging and how to measure it? Kelvin probe microscopy?
- Adsorption isotherms on polysilicon, and in narrow gaps
- Adsorption dynamics – relationship to crack healing in the adhesion problem.

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